

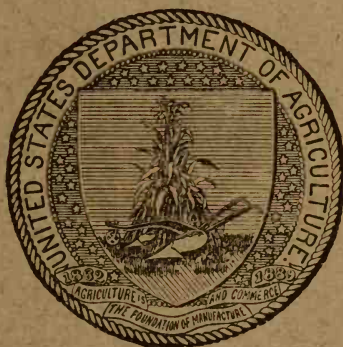
BULLETIN No. 31.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY.
GIFFORD PINCHOT, Forester.

NOTES ON THE RED CEDAR.

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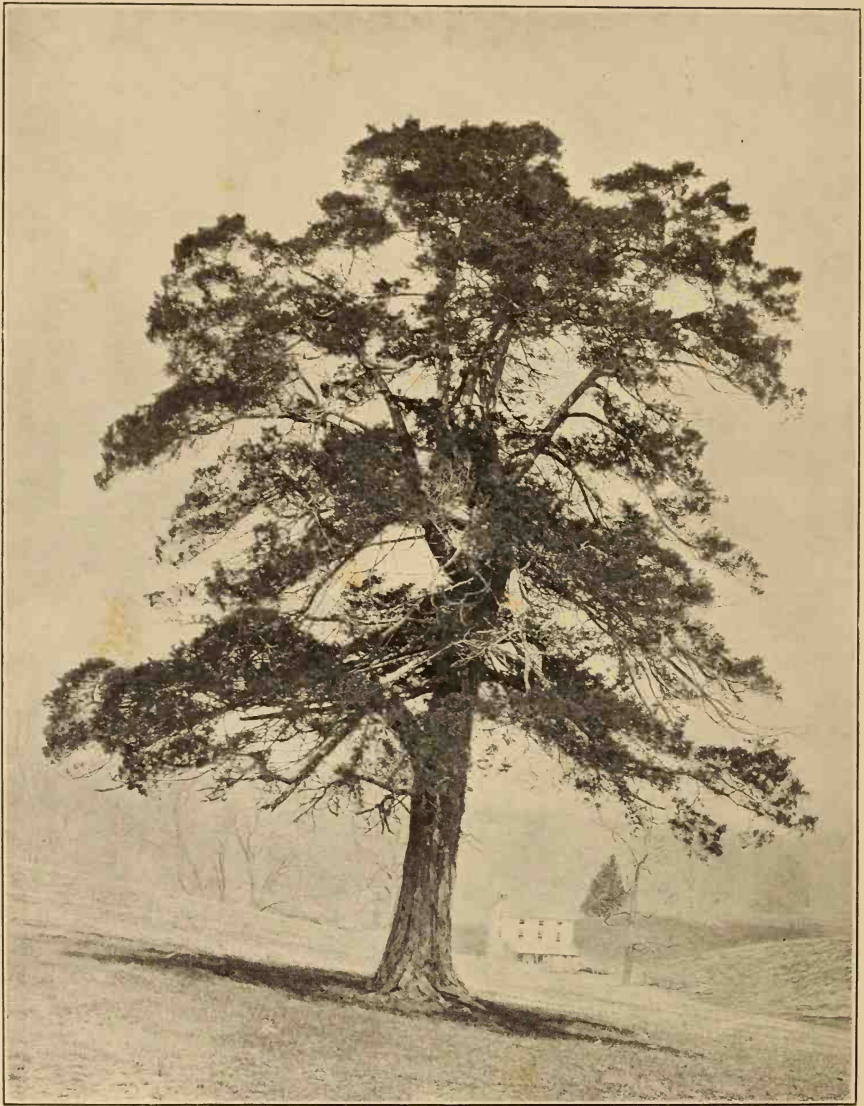
CHARLES MOHR, PH. D.,
AGENT IN THE DIVISION OF FORESTRY.



WASHINGTON:
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1901.

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RED CEDAR (*JUNIPERUS VIRGINIANA* L.).

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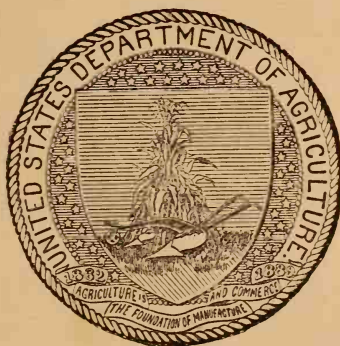
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NOTES ON THE RED CEDAR.

BY

CHARLES MOHR, PH. D.,
AGENT IN THE DIVISION OF FORESTRY.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1901.

THE RED CEDAR.

Juniperus virginiana L. Spec. Pl., Ed. I, 2: 1039. (1753.)

Synonyms:

Juniperus caroliniana Mill. Gard. Diction., ed. VIII, No. 4. (1768.)

Juniperus arborescens Moench. Meth., 699. (1794.)

Juniperus barbadensis Michx. Fl. Bor. Am., 2: 246. (1803.)

Juniperus foetida var. *Virginiana* Spach. Ann. Sci. Nat., II ser., 16, 298. (1841.)

Juniperus australis. Endl. Syn. Conif. 26. (1847.)

Juniperus sabina var. *Virginiana* Antoine Kupress., Tab. 83-84. (1860.)

LOCAL OR COMMON NAMES.

Red Cedar (New England, Middle Atlantic, and Southern States).

Cedar (Conn., Pa., N. J., Ky., S. C., Ohio, Ill.).

Savin (Mass., R. I., Conn., N. Y., Pa.).

Juniper (N. Y., Pa.).

Cedre (Louisiana).

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF FORESTRY,

Washington, D. C., April 25, 1901.

SIR: I have the honor to transmit herewith a paper by Dr. Charles Mohr, Agent in the Division of Forestry, entitled "Notes on the Red Cedar," and to recommend its publication as Bulletin No. 31 of this Division. With respect to forest management and the silvicultural characters upon which it depends, this paper is of necessity rather preliminary than final, and it is intended to supplement it hereafter by the results of a more detailed study of the Red Cedar in the field.

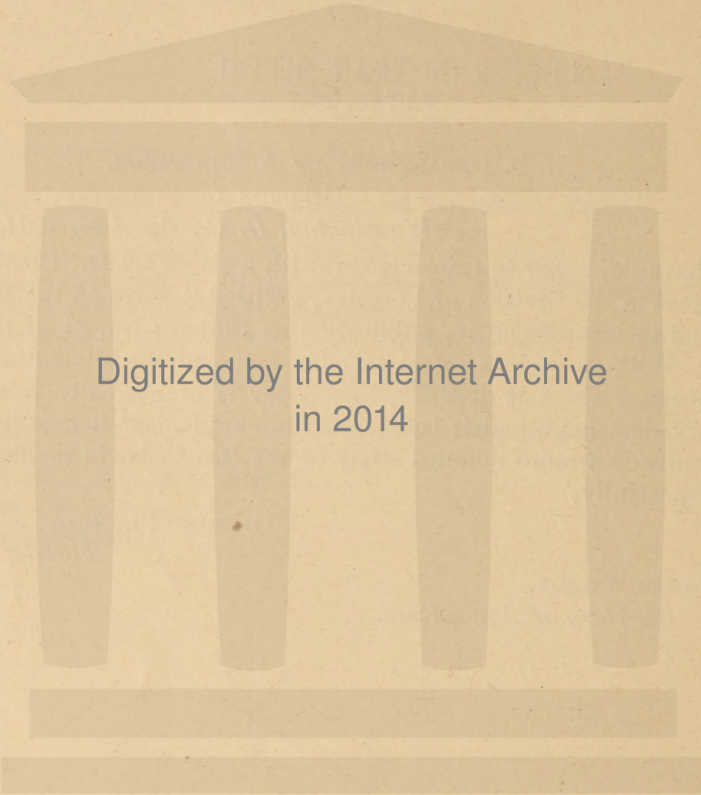
Respectfully,

GIFFORD PINCHOT,

Forester.

HON. JAMES WILSON,

Secretary of Agriculture.



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NOTES ON THE RED CEDAR.

(*Juniperus virginiana* L.)

INTRODUCTORY.

The Red Cedar is one of the most widely distributed of our forest trees. It is, however, only upon comparatively small areas, confined to the southeastern part of the United States, that it is of the quality required for the purposes for which the wood is most highly esteemed. Its durability, coupled with other characteristics, has made it almost indispensable for certain uses. No wood is more frequently in the hands of civilized man of every station of life than the Red Cedar of his lead pencil.

The demand for Red Cedar is fast outstripping the supply. As it is a tree of rapid growth, thriving under many conditions of soil and climate, and on land fit only for timber, this species is of great value in the economy of our forests. The question of the reproduction and maintenance of Red Cedar is, therefore, of no little practical importance.

HISTORICAL.

The Red Cedar attracted the attention of the first students of American botany, and of authors before the time of Linnæus, as well as of European horticulturists. The tree was already established, shortly after the middle of the seventeenth century, in English gardens and upon the continent of Europe. The value of its wood was recognized by the earliest writers on the products of North American forests. Wangenheim praised it as one of the most valuable and useful of timbers. He said:

It can justly be said that its usefulness extends from the bottom to the top, its red heartwood remaining unaffected by decomposition and by worms, and resisting equally decay under exposure to the atmosphere, to water, or to the ground.¹

The same writer says further that large sticks of this timber were sawn into planks used in shipbuilding, that the smaller were used for posts, and that these articles were the objects of a considerable trade.

¹ Wangenheim, Beschreibung Nord Americanischer Holzarten (1781).

Thirty years later A. F. Michaux wrote:

This useful wood is procured with difficulty and reserved only for the most important purposes, its reproduction being trifling in comparison with the consumption in the United States, particularly in the cities of New York, Philadelphia, and Baltimore. Its use in naval architecture, more than any other, has wasted the species, so that recourse must now be had to the coast of Florida between the St. Marys and St. Johns rivers, which will soon be exhausted in its turn.¹

DISTRIBUTION.

A. F. Michaux found the northern limit of Red Cedar on the Atlantic coast in southern Nova Scotia, and in the interior on Lake Champlain. Toward the west the tree extends under nearly the same parallel (44° to 44° 30' N.) to the southern shore of Georgian Bay, to northern Michigan, southern South Dakota, western Nebraska and Kansas, and southward to the eastern bank of the Colorado River, near Austin, in Texas.

As has been shown recently by Prof. C. S. Sargent, the Red Cedar of the West, formerly considered identical with that of the East, is a distinct species, for which he proposed the name *Juniperus scopulorum*. *Juniperus virginiana* does not extend farther west than the basin of the Mississippi River in the North, and the eastern slope of the Colorado Valley in the South.

With the recognition of the tree of the Gulf shore and eastern Florida as a distinct species—*Juniperus barbadensis* (Pl. II)—the southern limit of the northern Red Cedar, *Juniperus virginiana*, has become somewhat obscure, as it still remains doubtful whether the latter is indigenous to the coast region of the Gulf States, where it occurs together with the subtropical species. From what is known at present, it appears most probable that the species finds its southern limit on the coast in lower South Carolina, and westward on the limestone hills in the upper division of the maritime pine belt in Alabama and Mississippi. (See Pl. III.)

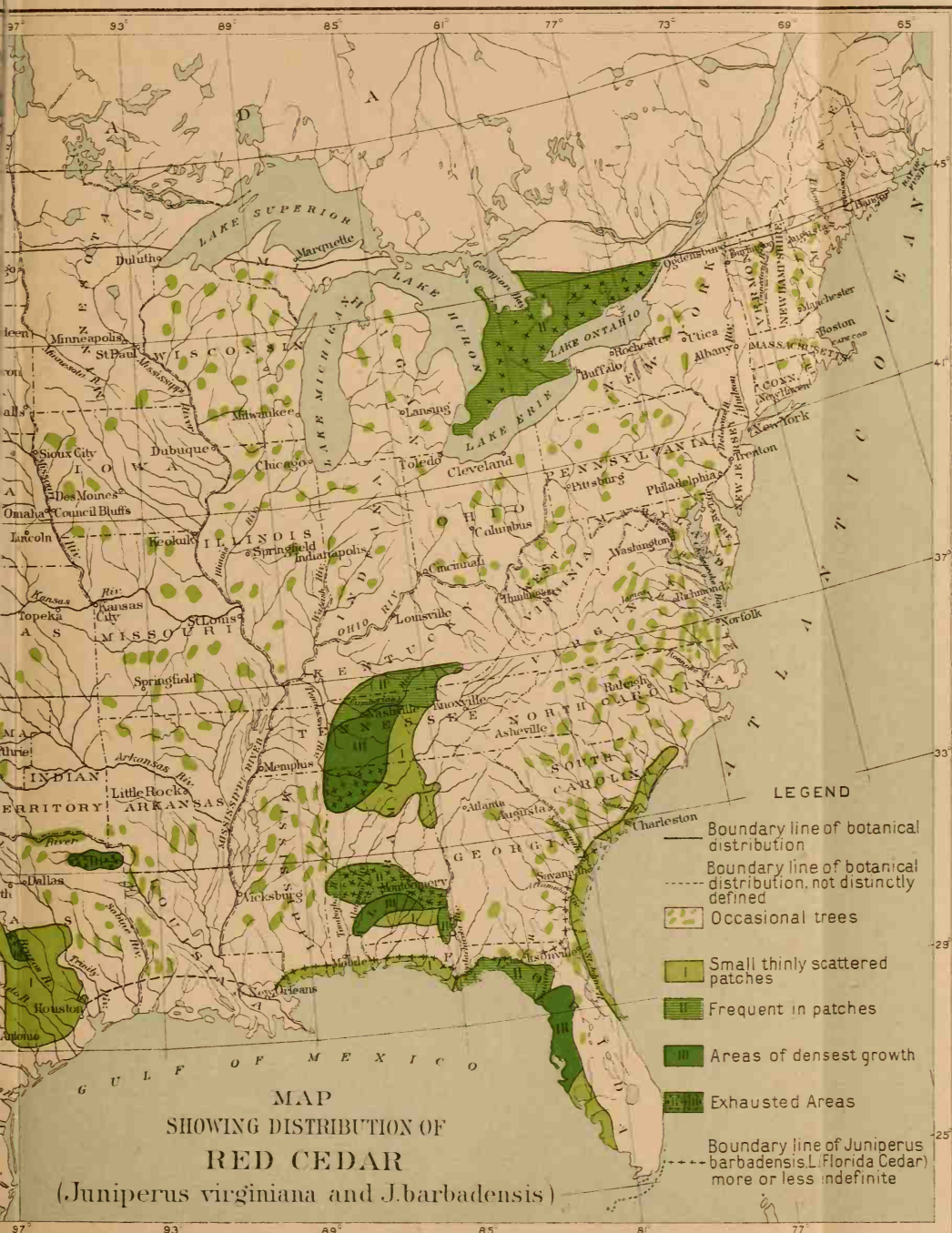
There is scarcely another tree of the East which exhibits a greater indifference to soil and climate than the Red Cedar. It thrives in the valley of the St. Lawrence and in New England; on the hills and limestone flats of the Southern States; on the exposed, arid ridges of Kansas and Nebraska; and on the deep soil of the hummocks of the Gulf coast, where the annual precipitation is 60 inches. It is, however, south of the thirty-sixth parallel that Red Cedar is at its best. It can, in general, be said that the tree requires for its best growth a rather light, loamy soil, containing lime; and that heavy clay and sand are not favorable to its development.

¹ A. F. Michaux, Histoire d'arb. forest. de l'Amériq. septen. 1810; and Philadelphia Edition, Vol. VIII, p. 173, pl. 155. 1857.



RED CEDAR (*JUNIPERUS BARBADENSIS* L.).





The Northern Red Cedar prevails most extensively in this State in the basin of the Tennessee River, and among the foothills of the mountain region. These valleys have been almost entirely stripped of marketable timber. The best trees are found scattered in the hardwood forests of the coves, on the declivities of the Warrior table-land, and in the narrow valleys intersecting the ridges of the Cumberland Mountains on the north side of the Tennessee River. Examinations made in the coves about Falkville, Morgan County, and elsewhere, show that Red Cedar formed originally 20 to 30 per cent of the forest growth. On the slopes and the benches, and in the narrow valleys with a calcareous, fresh, and fertile soil, the trees are large and the trunks free from knots, furnishing timber best adapted for hollow ware and for pencil wood. On the dry ridges of limestone rock which form the foothills, Red Cedar occurs almost pure. In such localities the stand is dense, and the trees are used chiefly for telegraph poles and piles.

The forests and cedar glades of the Tennessee Valley, with Falkville, on the Louisville and Nashville Railroad, for one of the principal shipping points, furnished for the last fifteen to eighteen years the larger number of the telegraph poles required in the lower Southern States by the Western Union Telegraph Company, amounting on the average to about 175,000 poles per year. Fifteen hundred carloads, averaging 65 poles each, and valued at \$146,000, were shipped from Falkville during the year 1890 for this company alone. The number of poles of smaller size, used to support electric wires and for piling, shipped during the same period was scarcely less. No figures could be obtained of the timber used in the manufactories of pencil wood and hollow ware, in operation in the valley. The telegraph poles required by the above company were of the same dimensions as the poles which reach the market of Nashville. On counting the annual rings of a number of them, they were found to have been taken from trees 120 to 160 years old. The depletion of the forest near the railroad has been proceeding at a rapid rate ever since. Of late years the timber has been hauled for long distances over the rough mountain roads. A visit to Falkville, in 1898, showed that the traffic in Red Cedar had entirely ceased, owing to its exhaustion in this part of the Tennessee Valley. In the narrow valleys and on the lower hills north of the Tennessee River, more difficult of access, Red Cedar is said to be still abundant. The frequency of the tree on the hills depends largely upon the nature of the soil. Wherever the strata of the Subcarboniferous limestone are overlapped by the silicious conglomerates and sandstones of the coal measures there is practically no Red Cedar.

The increasing scarcity of commercial Red Cedar along the railroads north of the Tennessee River was shown by the removal, a few

years ago, of the cedar-pencil works at Gurley. East of the oak barrens, from the western boundary of Madison County, the limestone forms extensive flats covered with Red Cedar. On these dry cedar barrens the trunks of the old trees are knotty from the base, and the wood is hard and brittle. This inferior quality of Cedar finds a ready market for fencing. In Jackson County these cedar barrens occur in patches, frequently of large extent. On the rugged limestone hills, unsuitable for the cultivation of crops, Red Cedar finds a safe retreat. After the merchantable material has been cut out, the younger, more or less suppressed trees grow rapidly, and seedlings and saplings easily hold their own against hardwood trees and deciduous shrubs. In the localities rarely exposed to fire, it is likely that before another half century has passed these forests will again yield merchantable timber.

Before the fertile lands of the central prairie belt of Alabama were cleared, its forests teemed with Red Cedar of superior quality. Only a comparatively small portion of these magnificent forests is now standing, the largest area still untouched lying between the Alabama and Tombigbee rivers. A remnant of a forest of Red Cedar and hardwood near Gallion in Hale County offered a good opportunity for the study of the condition of the cedar hummocks in their original state. The land covered by this forest is undulating, with a deep, rich, loamy soil. The stand is dense, and consists chiefly of Elm, Beech, Sugarberry (*Celtis mississippiensis*), White Ash, Sweet Gum, and Durand Oak (*Quercus breviloba*), with Red Cedar scattered among them. The latter forms from 35 to 40 per cent of the tree growth of these forests. Young Cedars occur frequently in the undergrowth, particularly in the openings. This young growth promises, however, little for the future, for it is stunted by the tramping and browsing of cattle.

In the upper division of the coast pine belt, particularly on the so-called hill prairies, where Tertiary limestone is the surface formation, Red Cedar furnishes large supplies of timber of high quality. On the arable lands of this region the forest trees have in a great measure disappeared, and it is only in the highly broken and rocky lands, too remote for ready transportation, that larger tracts of virgin timber have escaped the ax, as, for example, in the northwestern part of Butler County and the adjoining parts of Wilcox County. On the upper slopes and the crest of the hills, Red Cedar, which is here associated with Chinquapin Oak, Yellow Oak, Black Gum, Hard Maple, and Basswood, forms fully one-third of the timber growth, while on the lower slopes, where it is associated with Magnolia, Cucumber-tree, White Ash, Cow Oak, and Texas Oak, it is of large dimensions and forms fully one-half of the stand. Fallen trees were found from 90 to 100 feet high, clear of limbs for two-thirds of their height, and 2 feet and over in diameter $4\frac{1}{2}$ feet above the ground. Trees of this size are frequent, and several within sight at one time measured 30 inches in diameter breasthigh, their tall, tapering trunks ending in a slender, spiry top. A good many of the old trees are

unsound at base, and many have been thrown by wind. It is said that the wood of such trees has become softer than that of standing trees, and is, therefore, more valuable for pencils.

Young saplings and seedlings of Red Cedar seldom occur in the forests of these hill prairies. After the removal of the marketable trees, the ground, wherever cultivation is practicable, is almost immediately cleared. The forests about the headwaters of Cedar Creek furnish the supplies to the Gulf Red Cedar Works, situated on the Louisville and Nashville Railroad. For the past few years these works have been engaged exclusively in the manufacture of pencil slabs, which permits of the closest utilization of the highly defective timber. The waste resulting from defects due to decay and perforation of the wood by insects is said to be fully 60 per cent of the material sawn. The timber reaches the mills in lengths of about 25 feet; the logs vary in diameter from 15 to 24 inches and over at the butt, those of from 15 to 20 inches in diameter being most numerous. Logs of such dimensions show from 116 to 160 annual rings at the butt end, and a sapwood from one-half to 1½ inches wide. The number of rings in butt logs 20 to 22 inches in diameter varies between 160 and 180.

The cedar forests in Butler County are under the control of the company which owns the works just mentioned. They are connected with the works by a well-equipped railroad, which assures to this company regular supplies of timber for a number of years to come.

Outside of the hill prairies Red Cedar is scattered irregularly through the hardwood forests of the upper division of the maritime pine belt, which crosses Alabama with an average width of from 30 to 35 miles. All the hewn red cedar logs which are rafted down the Mobile and Tombigbee rivers to Mobile are brought from this region. The amount of such timber shipped annually to this market can not be stated, as the receipts are included under the head of "Hewn timber other than pine." Nothing is known of the amount for home consumption received at this port. Smaller shipments of Red Cedar are made to Pensacola and Bagdad, in western Florida, where they are used in the manufacture of boards, pickets, etc., for the export trade.

In the coast plain of Alabama, and in the same region from Florida to eastern Louisiana, this tree was a favorite with the early settlers to shade and embellish the grounds near their dwellings. Trees from 60 to 100 years old and over are still found in the suburbs of the cities and in hamlets on the coast. These trees, grown in the open, present a habit of growth strikingly different from that of the forest tree. The sturdy trunk, 2 to 3 feet and upward in diameter, divides at about 20 feet above the ground into heavy, wide-spreading limbs with numerous branches and drooping, slender branchlets, forming a dense head of a roundish or broadly oval outline.

Trees in every stage of growth are found along fences and hedge rows and the borders of woodlands. Red Cedar of the same spreading form occurs frequently in the valleys, on half-swampy hummocks

along the watercourses. The cultivated trees in the open are of quick growth. Felled trees observed in Mobile, from 12 to 13 inches in diameter breasthigh, the trunk free from limbs for 15 feet, and with a total height of from 50 to 60 feet, were found to be from 50 to 60 years old. The trunks of these trees are frequently hollow in the center, and the timber is fit only for posts, which find a ready market.

The ancient shell heaps, or shell banks, which border the numerous inlets of the sea, are frequently covered with patches of Red Cedar of low, spreading growth. Although the soil of these shell banks is fertile and to all appearances favorable to the tree, it often remains stunted when exposed to high winds.

FLORIDA.

Red Cedar is found in all parts of Florida, but is at present abundant only on the western coast, especially in the large swamps, of which the Chesahowitzka, or, as it is frequently spelled, "Chesawiskey," and the "large Gulf hummock" are the best known. Mr. Filibert Roth, who has investigated the cedar hummocks in this State, furnishes the following information on the subject:

In the wet swamps of eastern Florida and all sandy pine lands the Cedar is wanting. It occurs in eastern Florida only in the more fertile, half-swampy forests, where it is thinly scattered, mostly as old timber with little or no young growth, among the hardwoods and Palmetto, which, often with a sprinkling of Cypress and Loblolly Pine, cover these hummock lands. On the western side of the peninsula it is also restricted to the hummock lands and swamps. On the whole, more than 1,000,000 acres, or about 50 townships, with probably an average of a hundred cubic feet per acre, or a total of about 100,000,000 cubic feet, can be assumed to have been standing in Florida. At present it is believed to be largely cut out, and the supply reduced to little over 10 per cent of the original stand; 75 per cent of this must be looked for on the western hummocks. The tree occurs scattered among the hardwood timber, forming small groves by itself, and, as the predominating tree in the mixture, commonly covers considerable tracts in the western swamps. It is generally 40 to 50 feet in height (rarely more), quite straight, with a taper of 4 to 5 inches in the first 16 feet; the stump is generally not over 20 inches in diameter, rarely 3 feet.

The logging is carried on in a very primitive way. The supplies at the mills more resemble piles of ordinary cord wood than saw timber, and the methods are very economical, there being no waste of sound material. The average yield per tree is about 20 cubic feet, and per acre, when large areas are considered, about 100 cubic feet. In eastern Florida the red cedar hummock has completely disappeared from many localities. In the western swamp it is claimed that the ground might be logged over every fifteen or twenty years. Although this is hardly correct if the logging were done thoroughly, it is nevertheless certain that judicious lumbering need never exhaust the supply of Red Cedar, and might increase many-fold the present yield.

GEORGIA.

Small tracts of commercial Red Cedar are found scattered in the valleys of northwestern Georgia, where limestone is the surface formation. In Mississippi and Louisiana the tree occurs too sparingly to be of commercial importance.

NEBRASKA.

In this State Red Cedar is common, and is found as far westward as Sioux County. In some localities trees 2 feet in diameter have been observed.¹

NEW ENGLAND.

South of the Kennebec River the tree is more or less frequent upon the lower hills and in the valleys. It is common in old clearings and deserted fields, varying greatly in form and size, according to soil and exposure. Emerson described the tree when growing on the seashore and exposed to the wind as gnarled and twisted in form and seldom more than 20 inches in diameter.²

NEW YORK AND ADJOINING STATES.

In the upper valley of the Hudson and the northern and western parts of New York, and in adjoining parts of Pennsylvania, Red Cedar is frequent, and it is also common in northern and central New Jersey. It is, however, of inferior quality, fit only for posts. The wood is hard and brittle, of uneven and knotty grain, and is rarely of use in the mechanical arts.

TENNESSEE.

South of the Ohio River Red Cedar is found in greatest abundance and furnishes its best timber. Although most plentiful on the dry limestone flats of middle Tennessee and northern Alabama, it forms also a large proportion of the tree growth in the damp valleys of this region.

Red Cedar occurs throughout Tennessee, but is most abundant in the basin of Silurian limestone of middle Tennessee. Dr. A. Gattinger finds that in middle Tennessee Red Cedar covers patches from a few acres to several square miles in extent, which are the remnants of the cedar forests which originally covered a large part of this fertile region. The virgin growth of Red Cedar has for the most part disappeared with that of Black Walnut. Mr. Sudworth says that the tree was common, and its virtue of outlasting men and things well known, as evinced by the miles and miles of gray-brown rail fences of good Red Cedar looking hundreds of years old.³

According to Dr. Gattinger, Red Cedar occurs in groves in the counties of Wilson and Rutherford. The first of these is eminently a red cedar county. The town of Lebanon stands on a red cedar flat. It was observed by Mr. Sudworth that a large amount of the Red Cedar left is young growth, with low-branched crowns and trunks too small for telegraph poles, but useful for fence posts. There are

¹ Herbert J. Webber. Catalogue of the Flora of Nebraska, p. 96.

² Emerson. Trees and Shrubs of Massachusetts.

³ George B. Sudworth. Forest Flora and Conditions of Middle and East Tennessee: an address delivered at the autumn meeting of the American Forestry Association, held in Nashville, September 22, 1897.

also small bodies of prime old Cedar left in nearly all of the counties of middle Tennessee, which have escaped the attention of the hunter for pencil cedar.

The virgin Red Cedar is often several centuries old, and in some cases very large. Mr. Sudworth was shown fine sound timber averaging about three 5-foot logs to the tree. One butt log squared 37 inches, with an estimated age of 290 years.

Dr. Gattinger says also:

The principal cedar market is Murfreesboro, the large supplies of Red Cedar reaching this place by the eastern branch of the Louisville and Nashville Railroad from Bellbuckle, Normandy, and Montrose. A line run parallel with the Chattanooga and Nashville Railroad comes near to giving the eastern limit of the cedar belt. Here the oak barrens set in, underlaid by the Devonian and silicious Sub-carboniferous strata. The counties west of that line are only dotted with lesser patches of cedar glades.

According to the same observer, several large supplies of first-class red cedar poles formerly reached the city of Nashville by the extension of the Nashville, Lebanon, and Cumberland Mountain road. These poles averaged about 50 feet in length and from 18 to 24 inches in diameter at the butt. They sold for about \$3 apiece; and in this shape Red Cedar is said to be disposed of at the greatest profit. Good red cedar lumber sells in the market at Nashville for 8 to 10 cents a foot, board measure. Mill men find the cost unprofitably increased by the many defects common to this timber.

In Marshall County Red Cedar, associated with hardwood trees, forms a large part of the forest which covers the valleys and the lower slopes of the hills. It occurs in nearly pure woods on the broad, dry limestone flats, with only a shallow covering of soil, which extend throughout central and southern Tennessee eastward to the Tennessee River. The timber is more or less stunted and knotty, and serves largely for fence posts.

It is probable that, at the present rate of consumption, the supplies suitable for the manufacture of hollow ware, pencil wood, and lumber will be exhausted within a few years.

TEXAS.

Originally Red Cedar was frequent in the central limestone region of the State. Before the end of the first half of the nineteenth century the earlier settlers found it in abundance in the Brazos Valley, and more or less scattered on the limestone ridges east of the Colorado River. At present it is practically extinct all over this wide extent of country. Professor Sargent considers the valley of the Red River from the border of Louisiana as far west as Clarksville as the region where the tree reaches its best development.¹ From the observations of the writer, made in 1894, commercial Red Cedar has become scarce in this valley, only inconsiderable quantities reaching Texarkana, where they find a ready market.

¹ C. S. Sargent, *Garden and Forest*. 10:420. 1897.

So far as could be determined from the scanty material examined, the Red Cedar of eastern Texas is identical with the northern tree.

DOMINION OF CANADA.

Red Cedar is considered a comparatively rare tree in the Dominion of Canada, where it is confined to the limestone shingle along the River St. Lawrence and Lake Ontario. In the Bay of Quinte district, according to Prof. J. Macoun, many groves of considerable extent are found, which covered, as late as 1883, large areas along the lake shore and in the Niagara peninsula. The timber from this region is of inferior quality, and a large proportion of the trees are diseased. Professor Macoun reports that all the valuable Red Cedar in these districts has been cut.

ASSOCIATED SPECIES.

Owing to its wide distribution, Red Cedar occurs in mixture with many other trees.

In districts where the limestone is scarcely hidden by the shallow soil covering, as, for example, on the cedar barrens of middle Tennessee, Red Cedar forms an almost pure stand over large areas; on the rocky hills of the Tennessee Valley, with a moderately fresh soil, it is the predominating tree in mixture with, principally, Small-fruit White Ash (*Fraxinus americana curtisii*), Blue Ash (*Fraxinus quadrangulata*), Hard Maple, and White Oak. In the rich forests of the cretaceous plain of Alabama it is mixed with Beech, Sugarberry, maple, Shagbark Hickory, Pignut Hickory, Yellow Oak, and White Oak, and forms 20 to 40 per cent of the stand. In the hill prairies of Alabama, the Cedar, mostly of large size, is, on the lower slopes of the hills, associated with Magnolia, White Ash, White Basswood (*Tilia heterophylla*), Wing Elm, Post Oak (*Quercus minor*), and Mockernut Hickory; and on the upper slopes of drier soil, with Chinquapin Oak (*Quercus acuminata*), Ironwood (*Ostrya virginica*), Yellow Oak (*Quercus velutina*), Black Gum, and small Black Walnut. In eastern Florida it often occurs in mixture with Bald Cypress and Loblolly Pine, among hardwoods and Palmetto. Red Cedar predominates on the swampy hummocks on the western coast, often to the exclusion of other species. In the cedar glades of the Tennessee Valley young Cedar forms a large part of the undergrowth; it also abounds in the openings of the cedar hummocks in the prairie region of Alabama. It is rare, however, on the steep slopes of the hill prairies farther south.

PRODUCTS OF RED CEDAR.

The northern and southern species present no essential differences in the appearance and properties of the wood, and are not distinguished by the consumer.

The durability of Red Cedar, its lightness and softness, the ease with which it is worked, its compact, fine, even grain, and its susceptibility to a high finish, combined with a pleasing color and a strong fragrance, give it a wide range of application in naval construction and in various mechanical arts and industries.

Its great resistance to decay renders the timber of Red Cedar highly valuable. Its durability was recognized by the earliest settlers, who used it largely for house building. At present the heaviest drafts upon the supplies of Red Cedar are made for poles, piles, and cross-ties, for all of which its capacity to resist the effects of the weather render it especially suitable. To a lesser extent Red Cedar is employed in boat building and for furniture.

Large quantities of timber of higher grade are consumed in the manufacture of small cooperage, such as buckets, churns, and tubs. It is to be regretted that no estimates could be obtained of the amount of Red Cedar used every year in this industry, and of the value of the annual output of the chief manufactories of cedar ware in Virginia, North Carolina, Tennessee, and Alabama, owing to the fact that the same articles are made of White Cedar ("Juniper"), and the product of both indiscriminately included under the head of "cedar ware."

The production of the wooden case inclosing the rod of black lead which forms the lead pencil has attained truly astounding proportions, and the rapidly diminishing supply of red cedar wood especially adapted to this purpose is becoming a matter of serious concern to the firms engaged in the manufacture of pencils. Only wood of great softness and of straight, even grain, free from knots and defects, can be used for pencils. On request for information upon the subject, one of the largest firms engaged in the manufacture of lead pencils stated that fully 500,000 cubic feet of red cedar wood, the product of at least 125,000 trees, are in this country alone annually consumed in the manufacture of lead pencils, and, further, that about 75,000 cubic feet of the timber are yearly exported from the United States. The cedar wood from Florida is considered the best, and until lately three-fourths to seven-eighths of the world's supply of pencil wood was furnished by that State. Since the timber of many of the cedar hummocks has been exhausted, the supplies existing in the adjoining States, particularly in Alabama, southeastern Tennessee, and the Red River region in Texas, have been resorted to. Now the cedar woods in the center of Alabama and in the Tennessee Valley are rapidly on the wane. The cedar mills have already been shifted to new fields, and it will be but a few years until they have used all the Cedar within reach.

At the pencil-wood manufactory near Greenville, Ala., the logs are cut in sections $2\frac{1}{2}$ feet long and sawed lengthwise into boards from one-half inch to $3\frac{1}{4}$ inches thick, which in their turn are cut to the length of $7\frac{1}{2}$ inches; they are then cut into slabs three-sixteenths of an inch

thick, and finally into pieces of the standard widths of $2\frac{1}{4}$ inches and less ($1\frac{3}{4}$, $1\frac{1}{2}$, 1, and six-eighths of an inch), as the soundness of the material will admit. Assorted according to these five sizes, 100 gross of the slabs are packed into square wooden cases for shipment.

The waste of the sawn wood is often converted into fine shavings, like excelsior, and used in place of camphor and naphthaline to protect woolen goods and furs. The waste of the cedar mills is also manufactured into paper for underlaying carpets and for wrapping furs. Quantities of Red Cedar are used in Germany for cigar boxes.

The leaves and young twigs of Red Cedar furnish a volatile oil, which is sold to the drug trade, and brings about 20 cents a pound. A similar product is distilled from the wood, but it is of inferior quality and brings about half the price.

WOOD OF THE RED CEDAR.¹

SAPWOOD AND HEARTWOOD.

The sapwood is always narrow, commonly five-eighths to 1 inch thick. The number of rings in the sapwood varies with age and

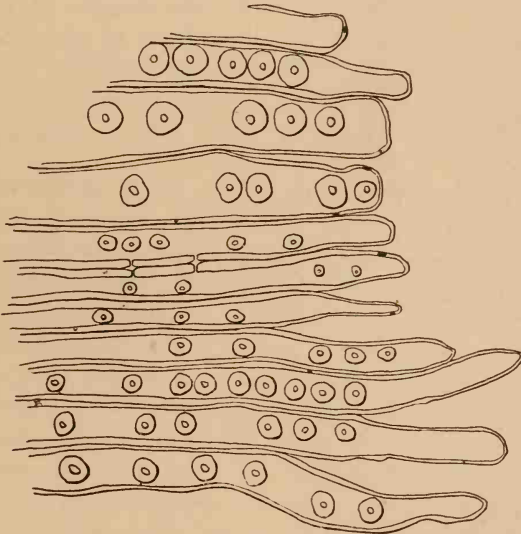


FIG. 1.—Radial section of inner wood: A number of cell endings, showing their arrangement, relative size of pits, and the pits of the tangential walls in the last cells of the summer wood—greatly enlarged.

rapidity of growth; 20 to 30 rings are counted in old, slow-growing trees, and from 8 to 15 in younger trees of thrifty growth. It is of a dingy white color. The heartwood is of a bright pinkish red, which

¹ The discussion of the wood of Red Cedar has been contributed chiefly by Filibert Roth.

changes with age to a deep reddish brown. In defective wood it is not uncommon to find the heartwood in streaks and spots out to the bark. Frequently the color of the heartwood near the sap is much brighter than farther in, and often it is not uniform, but shows a mingling of bright red and brown tints.

The wood is of an even, straight grain and is compact, owing to the numerous small, faint medullary rays. It resembles in this respect the wood of White Cedar (*Chamaecyparis thyoides*), which is, however, at once distinguished by its white color and want of strong fragrance. The spring wood passes gradually into the narrow bands of summer wood, which is rendered sharply distinct by the line forming its outer edge.

STRUCTURE.

In its elementary structure the wood of Red Cedar presents no essential differences from that of White Cedar. It is free from resinous ducts, which are confined to the primary bark. As in White Cedar, parenchymatous cells filled with resin are scattered throughout the summer wood and early spring wood.

The individual tracheid is quite uniform in its radial diameter; its end is abrupt, usually slightly bent or distorted (fig. 1). In the cross section the cells are quadratic, with the walls of equal thickness; in the later portion of the spring wood they become gradually thickened,

and only in the few rows forming the latest part of the summer wood

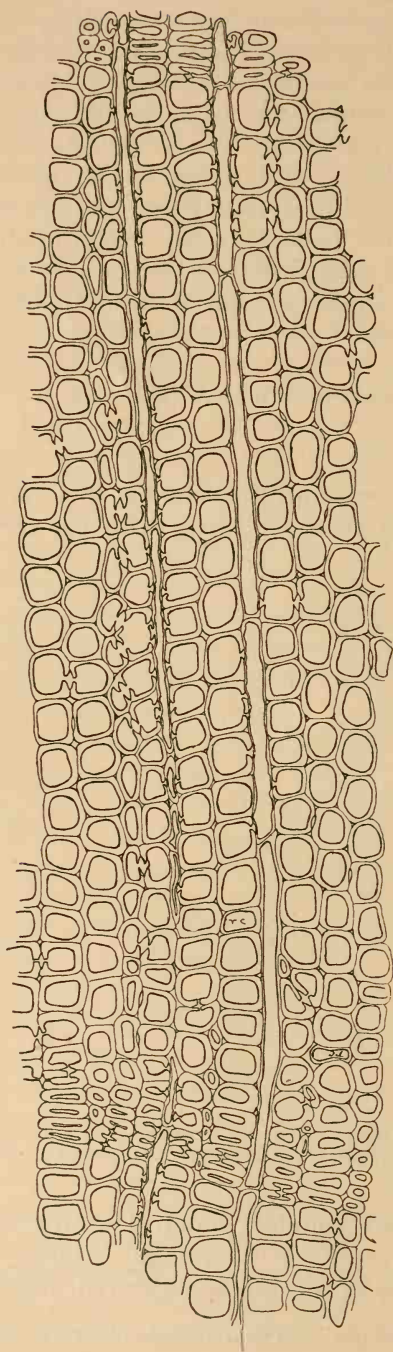


FIG. 2.—Cross section of part of annual ring; rc, resin cells—greatly enlarged.

do they become compressed and oblong, with their thickened walls

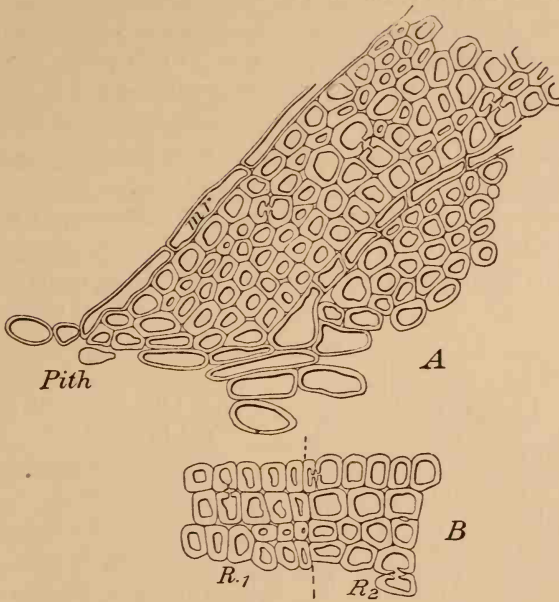


FIG. 3.—Wood cells near center: *A*, part of cross section from near the center; *B*, end of ring 1 and beginning of ring 2—greatly enlarged.

exceeding their lumen (figs. 2 and 3). The pits are bordered where

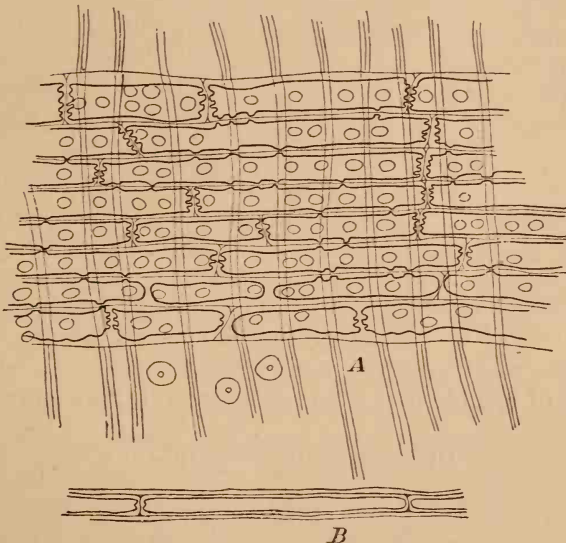


FIG. 4.—Radial section of mature wood: *A*, part of medullary ray; *B*, resin cell—greatly enlarged.

they communicate with the medullary rays (fig. 4, *A*). There are

numerous pits on the tangential as well as on the radial wall. The radial diameter of the tracheids is small, averaging 14 mm. in the center of the wood and 19 mm. in its peripheral parts. The medullary rays are simple—that is to say, they are 1 cell wide, as is general in conifers, and from 1 to 12 cells high; rays of from 2 to 6 cells are most frequent (figs. 4 and 5). The rows of cells are uniform, all with the inside wall smooth; their perforations are simple, mostly from 2 to 4 in the larger tracheids of the spring wood adjoining the ray and 1 or 2 to each tracheid of the summer wood. The contents of the medullary rays are frequently resinous. The parenchymatous resin cells, in short rows or single, are scattered in the spring wood or among the tracheids of the summer wood.

PHYSICAL PROPERTIES.

The physical and mechanical properties of the wood are subject to some variation due to differences in local conditions. The lightest and softest wood is produced on the swampy hummocks of the lower Southern States, notably in Florida. Mr. Roth states: "From what was seen in the woods of Florida, these properties vary within narrow limits, though even here softer and harder wood is distinguished. Apparently some change takes place after the tree has reached full growth, the wood becoming softer with age. It is on this account that the wood of the old shells of rotten logs is considered so

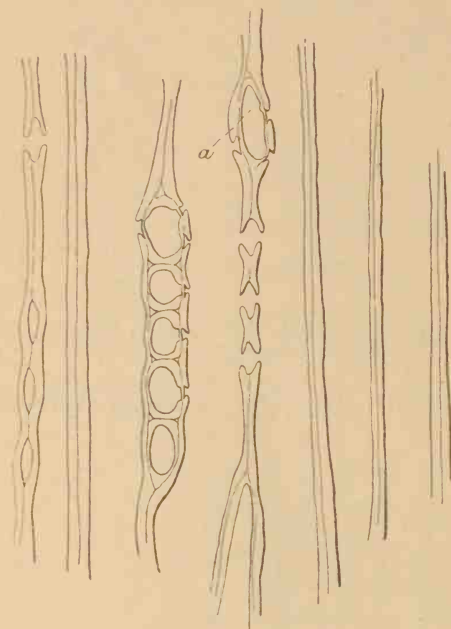


FIG. 5.—Tangential section of mature wood: *a*, a medullary ray of but one cell row. These are quite common—greatly enlarged.

well adapted for pencil wood." The same fact has been observed in the hollow logs of fallen timber in northern Alabama. The specific gravity of the wood varies between 0.45 and 0.50, and averages 0.4926. The weight of a cubic foot of air-dried wood is 30.7 pounds.

GROWTH AND DEVELOPMENT.

IN EARLY YOUTH.

The seeds germinate tardily. They may remain for the larger part of the year in the ground without sprouting; in fact, they germinate mostly in the second year.

After unfolding their cotyledons, or seed leaves, the development of the young plants proceeds steadily, and they are soon covered with the sharp primary leaves. At the end of the first year the seedlings are about 4 to 5 inches high. At this early stage of growth the development of the root system proceeds rapidly. At the beginning of the second year the rootlets are of the same length as the plantlet, and the stem produces branches from 1 to $1\frac{1}{2}$ inches long. The slender taproot sends out numerous laterals, which in their turn branch profusely, the fine hair-like rootlets penetrating the fissures of the ground to seek the needed supply of moisture. Thus at this early stage of its development the plant is preparing to gain a firm hold upon the rocky soil to which it is most frequently confined. With the fourth year the seedlings are from 8 to 12 inches high, and the tree enters upon a period of rapid growth. The scale-like foliage leaves make their appearance on the smallest branchlets. During the fifth and sixth years, upon a moderately fresh soil, the tree attains a height of 4 to 5 feet and over, with the stem three-eighths to one-half of an inch thick near the base. Before the end of the fourth season the primary leaves are almost completely replaced by the foliage leaves. On the shallow soil of dry limestone flats and sandy or gravelly hills the primary leaves are retained longer.

In the forests of the Tennessee Valley trees from 10 to 15 years old, scattered among the hardwoods, were found from 7 to nearly 12 feet high, and from three-fourths of an inch to 2 inches in diameter. In the same locality trees from 15 to 20 years old were found to vary greatly in their dimensions, being from 10 to over 18 feet in height and from $1\frac{3}{4}$ to $2\frac{1}{2}$ inches in diameter. Trees 20 to 30 years old, or a little over, are generally 18 to 24 feet high and $2\frac{1}{2}$ to 3 inches in diameter, the stems clear of limbs 6 to 7 feet above the base. On the sandy dry hummocks in the vicinity of Mobile, stocked with Live Oak, Loblolly Pine, Magnolia, and Yaupon, trees of the age just named average 12 feet in height, branching at the height of 4 to 5 feet above the ground. Two trees which sprung up in the garden of the writer and were transplanted when 4 years old are now 26 years old, and are 25 feet high with a diameter of 11 and 12 inches at breastheight, the soil being a moderately damp, highly sandy loam, with rather compact, retentive subsoil. These trees stand free.

Between the ages of 40 and 65 years the disparity in the size of trees of the same age varies according to differences in soil conditions. A tree growing in the hardwood forest near Russellville, in Franklin County, Ala., on rather shallow soil, showed 55 rings on the stump 18 inches above the ground, and measured 38 feet in height and 12 inches in diameter. In the forests of Franklin County 50 to 60 per cent of the mature trees were affected by decay. They were from 150 to 200 years old, and measured 15 to 22 inches in diameter and 75 to 80 feet in height.

As there is little danger of damage from fire and live stock in the coves of the Tennessee Valley, the prospect is good for the production of a second crop of marketable timber within a comparatively short time. The timber from Butler County varies from 14 to 20 inches in diameter. The logs brought to the mill are generally 24 feet long; those seen at the mill were not considered typical, representing the remnants of a tract in the rugged hills which has been culled over and over for the past dozen years. They were mostly much affected by decay, stunted, and knotty. In consequence, but few measurements were made; these showed that the trees 18 inches in diameter at breastheight were 115 to 125 years old, and those of a diameter of 16 to 22 inches, 130 to 150 years old.

The following diagram (fig. 6), showing graphically the rate of growth of Red Cedar in height at various ages, has been constructed from measurements of 57 trees in Alabama.

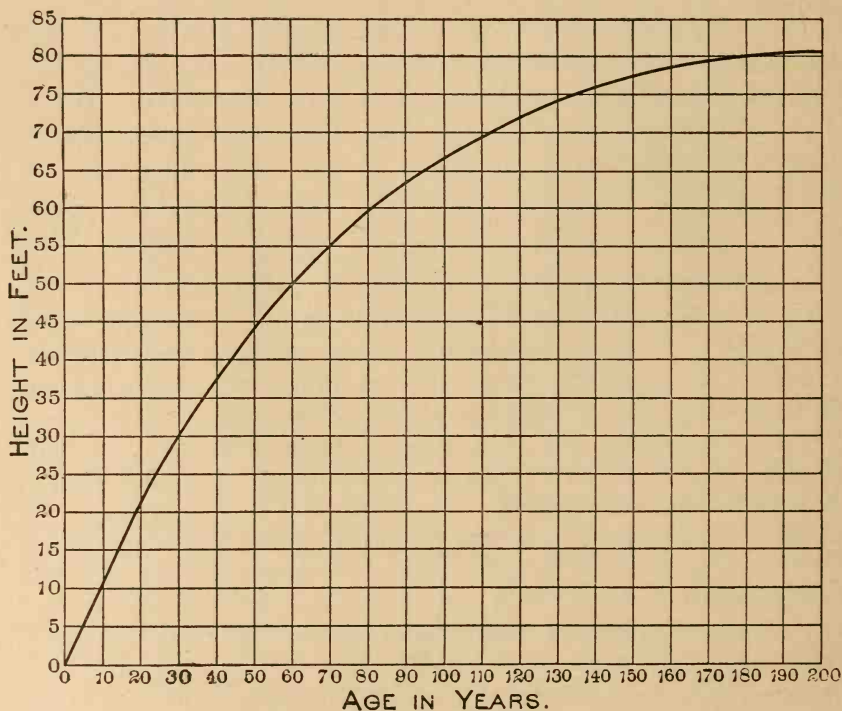


FIG. 6.—Rate of growth of Red Cedar.

IN MIDDLE AGE.

In the rich calcareous soil of a small cove at Cedar Plain, Morgan County, Ala., the rapidity of growth of Red Cedar was most strikingly exhibited by a group of trees which had sprung up in an open spot where they had been left for shade, and the ground around had been frequently plowed for the cultivation of vegetables. All the

trees were of uniform size, about 12 inches in diameter and about 25 feet high, with trunks clear for 7 feet. The proprietor stated that these trees were only 12 years old. In the adjoining cedar groves with a dry soil, covered by huge fragments of limestone rock, all the merchantable timber had been cut. Of the few trees remaining, measurements were taken. The following are the results in the case of one tree:

Diameter, breasthigh, 18 inches. Rings on radius of $7\frac{1}{4}$ inches, 70

	Rings.
For the first inch from center	14
For the second inch from center	8
For the third inch from center	8
For the fourth inch from center	8
For the fifth inch from center	9
For the sixth inch from center	9
For the seventh inch from center	9

Sapwood, $1\frac{1}{2}$ inches, showing 18 rings. Bark, three-eighths of an inch thick. First log, 16 feet long, and 11 inches in diameter at top. Second log, 12 feet long, very knotty throughout. Total height of tree, 56 feet. Timber sound throughout.

Another tree, 14 inches in diameter breasthigh, showed on the stump, 18 inches high, 69 rings. On the radius of $6\frac{1}{2}$ inches were counted:

	Rings.
For the first inch from center	11
For the second inch from center	8
For the third inch from center	9
For the fourth inch from center	6
For the fifth inch from center	8
For the sixth inch from center	17
For the remaining half inch	10

Sapwood, $1\frac{1}{2}$ inches, with about 20 rings. Length of timber (to crown), 24 feet; diameter below crown, $7\frac{1}{2}$ inches. Total height, 60 feet. Timber sound.

Mr. Roth, in discussing the growth and development of Red Cedar in Florida, says:

In the swamps of the western coast of Florida the Red Cedar is represented by young growth from the seedling up, and the stands are generally dense. For this reason the growth in the young stage is rather slow in diameter, but height growth progresses at from 4 to 18 inches per year. The leaders of young trees (in 1897) from 3 to 10 feet high were generally from 8 to 14 inches long. In the very dense groves of Cedar in the hummocks it would appear that a height of 40 feet and more is attained at the age of about 50 to 60 years. The diameter growth in all fairly favorable situations may be set down at about 0.1 inch a year, so that about five years are required to grow 1 inch in diameter. The native cedar men say that the Cedar grows 1 inch in circumference every year, or 1 inch in diameter every three years, but their view is based on growth of trees several inches thick, and is a little too high.

For the production of timber of the best quality Red Cedar requires

from 70 to 120 years, after which the growth declines and decay is apt to set in.

Age and diameter of Red Cedar in western Florida.

(FILIBERT ROTH.)

Age.		Age.	
Years.	Inches.	Years.	Inches.
43	7.25	80	10
44	7.75	81	7.5
46	8	82	9.5
50	8	83	7.25
52	7	88	11
52	8.5	90	8.25
52	10	91	6.75
53	8	91	8
53	10	94	9.75
54	6.5	95	11.50
55	14	100	6.50
60	7.5	100	10.5
63	8.5	100	10.75
62	10.5	101	7.5
67	10	106	9
72	10	113	18.5
73	8	113	10
73	12	116	12
73	9	126	12
74	8	125	15
75	10	140	14
80	9.25		

Total height and clear length of Red Cedar in eastern Florida.¹

(FILIBERT ROTH.)

Total height.		Total height.	
Feet.	Clear length.	Feet.	Clear length.
46	12	59	24
51	27	48	18
48	20	50	
42	25	59	12
40	22	38	8
36	24	38	8
48	28	32	14

¹ Young, thrifty pole timber, which had generally reached the end of active height growth.

ENEMIES.

FIRE.

Fires are highly disastrous to Red Cedar, both on account of the thin bark and the flat root system. In pure cedar forests a fire generally kills practically all the trees. In mixed forest, where the soil is fresher and the fire less fierce, the Cedars are rarely killed outright. They are, however, severely damaged by even a slight charring at the

butt, and it is probable that much of the decay characteristic of old Cedar is the result of fire.

LIVE STOCK.

Cattle and goats browse freely on the young plants and tender shoots.

FUNGI.

Of fungoid parasites, several species of Gymnosporangium, such as *G. globosum*, *G. macropus*, and *G. nidusavis* frequently infest Red Cedar. These fungi cause hard globular excrescences on the branches covered with the gelatinous mass inclosing the teleutospores. From these woody swellings, popularly known as "Cedar apples," rise tufts of branches which are called "Witches broom," and which so frequently disfigure the European Fir. The injury caused by Gymnosporangium consists mainly in the death of the branches infested by the fungus.

As has been observed at Greenville, Ala., the wood affected by the decay characteristic of the old trees is covered and permeated by the fine thread of a loose cottony mycelium, which feeds upon the substance, and causes its destruction. The wood attacked in this way becomes a deep chestnut brown. This dry rot is probably of the same nature as the disease which affects the old trees in Florida mentioned by Mr. Roth, and which is spoken of as "brown dote" by the loggers in that section. On the outside of newly felled timber affected by this rot in Butler County, Ala., a white, dry, polyporous fungus of the genus *Poria* was frequently found, forming crusts one-eighth inch thick, scarcely one-half inch wide, and about an inch long, disposed in straight, almost continuous rows. It is probable that this fungus is the fructifying part of the mycelium causing the rot, although the matter awaits further investigation.

Prof. H. von Schrenk¹ recognizes two distinct diseases of Red Cedar caused by the mycelium of polyporous fungi, the white rot and the red rot, or peckiness, of the Red Cedar. Both of these disorders render the timber useless, and both affect the tree in widely separated localities and under various conditions of climate and soil. In many localities fully 60 per cent of the timber is more or less affected by them. All that can be done is to check their spread through the destruction by fire of the fructifying bodies of the fungi wherever they are found.

The white rot (*Polyporus juniperinus* Schrenk) shows itself in the beginning by a slight discoloration of the heartwood toward the center, the woody fiber becoming finally perfectly white by the destruction of its lignin substance, and leaving the cellulose as a fine white film or soft webby threads. With the increase of the mycelium the fiber

¹ Bulletin No. 21, Division of Vegetable Physiology and Pathology, U. S. Dept. of Agriculture, Washington, 1900.

of the adjoining rings is affected, and in the course of the disease the central mass of the wood becomes completely changed and destroyed. Besides the change of the fiber to cellulose, the threads of the mycelium (hyphæ) attack the bordered pits, causing their destruction and the rapid disintegration of the remaining parts of the tracheid. At the same time the hyphæ destroy also the tissues of the medullary rays, causing narrow cavities radiating in the cross section in all directions from the center of the attack; the wood becomes yellowish brown, brittle, and finally crumbles, by the slightest touch, to a fine powder. The fructifying body shows that this fungus is an undescribed species of *Polyporus* named by Von Schrenck *P. juniperinus*.

In the red rot of the Red Cedar (*Polyporus carneus*) the red color of the heartwood is changed to brown. With the deepening of its color the wood shrinks and cracks. The altered wood is chemically greatly changed. It has the appearance and properties of brown charred wood, is very brittle, and lighter than the sound wood. The cavities appear in the cross section as roundish holes, and the line of demarcation between the sound and affected wood is very sharp. No mycelium is found in the sapwood; the wood between the affected spots is penetrated by hyphæ. In old trees the pockets near the base of the tree become so large, by the uniting of the lesser pockets, that the unaffected sapwood is no longer able to support the tree, and it is frequently broken off by wind.

INSECTS.

Red Cedar suffers more or less severe damage from attacks of insects of various orders. Of Coleoptera, the Juniper Bark-borer (*Phæosinus dentatus* Say.), is found in living and dead trees. This insect was observed in New England, but whether the death of the tree resulted from its attacks was not ascertained. In Kansas it was found very destructive to Red Cedar. The damage was evidently done by the perfect beetle burrowing under the bark at the base of the lateral shoots of the branches and eating around the base of the twig. Every twig was attacked, and a few insects were observed on the trunks of the trees themselves. This bark borer has been introduced in cedar posts brought to the lumber yards from Michigan and Arkansas. Le Conte states that it inhabits the Middle and Eastern States and Canada. This beetle has so far not been observed in southern Alabama.¹

The Prussian Blue Pine-Borer (*Callidium antennatum*)² has been found with the above in dying and dead trees. Of Lepidoptera, the male and female larvæ of the Juniper Basket-worm (*Thyridopterix ephemeræformis*) feed on Red Cedar. The larvæ may be found at all seasons and in various stages of growth. They are often abundant

¹A. S. Packard, Fifth Report U. S. Entomological Commission, Washington, D. C., 1890.

²A. S. Packard.

enough to prove injurious to the tree. Dr. R. Duggar states that the basket-worm has done great damage in Hale County, Ala., particularly to young trees. This insect can be destroyed by picking it off by hand or spraying the tree with an arsenical solution.

The Juniper Twig Inch-Worm, the larva of a small moth (*Drepanodes varus*), also feeds on the leaves of the tree. This caterpillar is a rough-bodied span or measuring worm, about $1\frac{1}{2}$ inches long, and bears a close resemblance to the smaller twigs of the tree; it changes to an ocher-brown moth. It is not rare in New England, and has also been observed in northern Alabama.

A firm engaged in the manufacture of pencil wood mentions that little holes of the size of a pin, caused by pinworms, are sometimes found in Red Cedar, and further speaks of the "borer," a small caterpillar with two small, finger-like cutters projecting from its head, as the greatest source of destruction of pencil cedar. This worm is said to eat or to bore its way through the log, leaving the hole it makes filled with fine sawdust. Large logs that would otherwise be of great value are frequently honeycombed and a mass of sawdust. This is from all appearances the work of some Longicorn beetle. A similar state of affairs in the timber of the Red Cedar has been observed among the logs at the cedar pencil mill at Gurley, Ala., and recently at the pencil wood manufactory near Greenville, Ala., made by the grubs of Capricorn beetles, larger than those described above. F. Roth states that the tree suffers frequently in Florida from the attacks of boring insects, followed by the white ant, which completely riddles the logs, and that it is owing especially to these insect ravages that there is so much waste in the manufacture of Red Cedar. The large hollows so frequently found in the trunks of the old trees planted near houses on the coast of Alabama and Mississippi, are inhabited by colonies of the large black wood ants. It can not be stated, however, whether they injure the tree.

NATURAL REPRODUCTION.

Red Cedar reproduces freely throughout its natural habitat, and most abundantly on limestone soil in the Southern States. The birds feeding upon its fruit assist in no small measure to scatter the seed. The young growth has a decided advantage over that of most of the trees with which it is associated on account of its tolerance of, or power to endure, shade. It is found spreading over abandoned grounds in New England and over the limestone hills and flats in the South, and holds its own on the cedar hummocks of the prairie region and of the Gulf shore. As a rule, it predominates largely among the young growth wherever Red Cedar originally abounded. An exception to this rule is found only on steep slopes, where the seeds are apt to be carried away by heavy rains before they have had time to germinate.

FOREST MANAGEMENT.

The following notes on the form of forest management advisable for Red Cedar are of a preliminary nature only. A good deal more study on the ground is necessary before it will be possible to decide how the conservative lumbering of red cedar forests had best be carried on. This investigation will be undertaken in its turn by the Division of Forestry.

The present scarcity of marketable Red Cedar, coupled with the great importance of a steady and adequate supply, makes systematic forest management imperative. The high quality of the wood in the Southeast, its comparatively rapid growth, and the ease with which reproduction can be obtained, indicate this region as the one best suited to the growth of Red Cedar and to the application of forestry with a prospect of successful management.

The fact that Red Cedar bears seed every year and that the seedlings are decidedly tolerant of shade renders its reproduction by no means a difficult matter. This is true in all localities favorable to the growth of the tree, as on the cedar hummocks of the prairie belt in Alabama, in the forests on the hills of the Tennessee Valley, and in the cedar hummocks of western Florida. It is evident that, under proper management, Red Cedar might be made to yield a steady supply of valuable timber. This would require the protection of the forest from fire and live stock and slight modifications of lumbering methods, so as to avoid unnecessary damage to the forest. It is probable, also, on account of the high merchantable value of Cedar even of small diameter, that a more intensive system of management could be applied to cedar forests than is generally advisable in this country. Thinnings, generally impossible on account of their expense, would in the case of the Cedar be likely to yield a fair revenue in addition to their good results from a silvicultural point of view.

Upon barren flats and dry limestone hills, where scarcely any other tree besides the Cedar can succeed, the dense undergrowth should be carefully preserved in the removal of the merchantable timber, and a sufficient number of seed-trees should be left standing. Denuded of their forest growth, these cedar barrens become absolutely unproductive, and to restock them with Cedar would be exceedingly difficult, if not practically impossible. On the other hand, by the exercise of a reasonable amount of care in logging they can be made to produce a steady supply of pole timber. More detailed directions along this line must await the results of further investigation.

The attempt made by L. von Faber to establish a forest of pure Cedar in central Germany has so far met with encouraging success. The three-year-old seedlings from the nursery were planted about the middle of the seventies. The plantlets, scarcely $1\frac{1}{2}$ feet high, sur-

vived the extraordinarily severe winters of 1879-80 and 1880-81, which caused great damage to trees and plants. In the year 1896 the trees showed a clear length of 12 feet, and the plantation was thrifty and promising.

RED CEDAR PLANTATIONS.

Red Cedar plantations are best established by using seedlings from the nursery. To hasten germination the berries should be soaked for some time in hot water as soon as they are ripe, and then mixed with sand and kept moist until the following year. They may be planted either in the fall, a year from the time they were gathered, or in the following spring. Treated in this way the seeds will sprout in a few weeks after sowing. The seedlings should be transplanted in the spring of the second season, about 5 inches apart. By the end of their second year the plants will be 7 to 8 inches high and well rooted. It is best to transplant again at the opening of the third season, setting them out in March or April, about 8 or 9 inches apart. When finally transplanted in the following spring the plants should be taken up with a ball of earth and planted at a distance of 4 feet apart, and well watered after planting. They will soon shade the ground, and need no further care. When they reach the pole stage, and before the period of most active growth has been passed, thinning will become necessary from time to time for the sake of an increased rate of diameter growth. The young poles and saplings furnish material for fencing, stakes, and hoops, yielding an income which will go far toward covering the expenses of the management of the plantation. At a diameter of 6 inches the tree furnishes excellent posts.

The formation of the heartwood begins early, and trees scarcely 10 inches in diameter and but little over fifty years old will furnish pencil wood.

NOMENCLATURE AND CLASSIFICATION.

The name under which the Red Cedar was described by Linnæus, *Juniperus virginiana*, has received from the first general recognition in systematic botany, and will stand unaltered. The common name of the tree, which is derived from the color of its wood, is not appropriate, as it can not be classed with the cedars. Savin, the name by which it goes in many localities, if *American* were added, would be strictly correct, the tree belonging to the natural section or subgenus *Sabina* (savin) of the genus *Juniperus*. The true savin differs from *Junipers* proper by the presence of primordial leaves in the early stage of its growth and by the conrescent, scale-like leaves of the older trees.

BOTANICAL DESCRIPTION AND MORPHOLOGY.

Evergreen trees from medium to moderately large size with somewhat obscurely angled to flat branchlets. Leaves dimorphous, those

of the older tree decussate, scale-like, with entire margins, acute; in

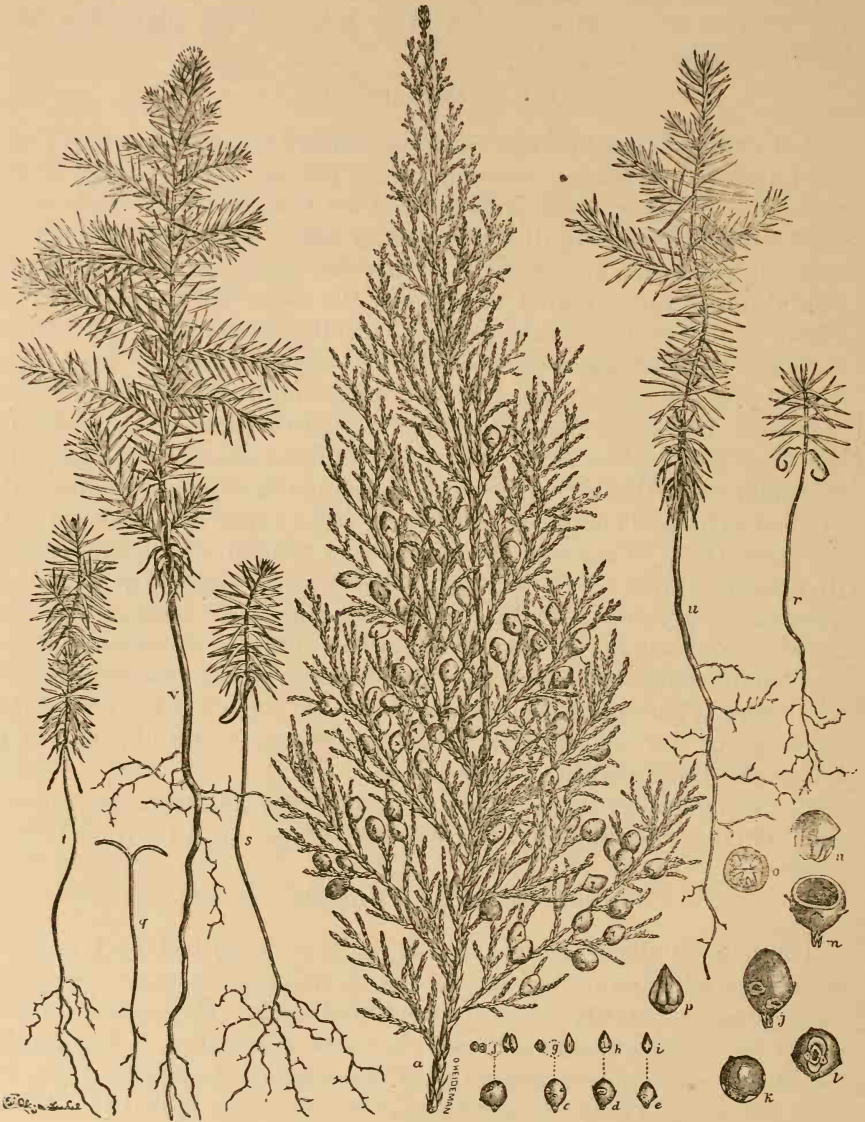


FIG. 7.—Red Cedar seeds, plantlets, etc.: *a*, fruit-bearing branch—natural size (November); *b*, *c*, *d*, *e*, strobiles in different stages of development; *f*, *g*, *h*, *i*, strobiles with their seeds; *k*, mature fruit (galbulus), seen from above; *l*, mature fruit, from the side; *m*, mature fruit, with seeds removed; *n*, galbulus, pulp removed about the base; *o*, cross section, through base of fruit; *p*, seeds—enlarged; *q*, seedling with cotyledons just unfolded—natural size (February); *r*, plantlets several weeks old; *s*, same, little over a month old, primary axis yet undivided; *t*, primary stem producing secondary axis; *u*, seedling 5 to 6 months old; *v*, same at the end of the first year. Plantlets all covered with the acerose primary leaves, natural size. (Drawn from specimens collected in the District of Columbia.)

the earliest stages of growth and on the youngest shoots of older trees

in whorls of three, rigid, needle-shaped, acute. The fruit, a small, short-stalked, fleshy conelet, is globular, berry-like, of a dark purple color, with a whitish bloom, and incloses one or two angular grooved seeds.

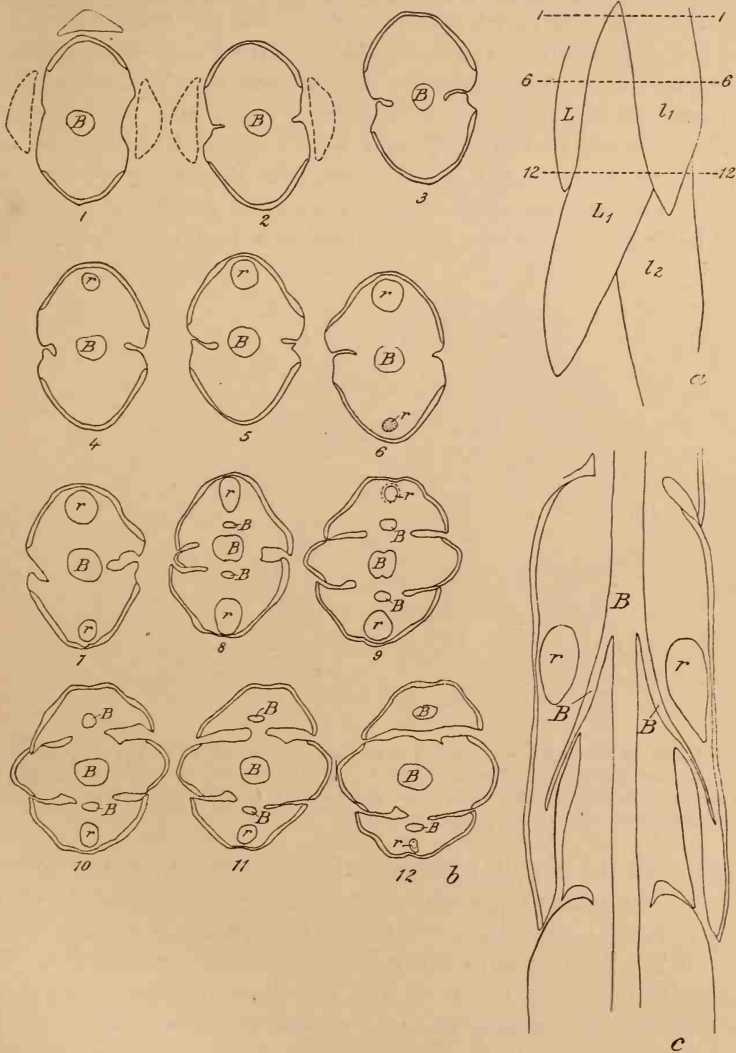


FIG. 8.—Leaves of Red Cedar:

a, arrangement of leaves on twig, dotted lines showing position of cross sections.

b, series of cross sections: *B*, fibro-vascular bundles; *r*, resin pockets.

c, longitudinal section: *B*, referring to fibro-vascular bundles; *r*, to resin pockets as in b—enlarged.

ROOT, STEM, AND BRANCH SYSTEM.

The root system of the Red Cedar is flat, and the taproot is at the earliest stages far exceeded in length by numerous densely branched lateral roots.

The full-grown tree varies greatly in shape and size; as generally met with in the cedar glades, it reaches a height of 50 to 75 feet, free from limbs for half of its length, and from 12 to (rarely) 20 inches in diameter at breastheight. The trunk is often fluted at the base. On the dry limestone flats of the barrens and on poor sandy hills the tapering trunk is covered with branches from the base, and is full of knots and dead limbs. It attains its best growth associated with hardwood trees, in the fertile valleys and on the rich benches and in the coves and on the hillsides, with a deep, fresh soil; here it reaches a height of from 75 to 100 feet, clear of limbs for 50 to 60 feet, and is from $1\frac{1}{2}$ to $2\frac{1}{2}$, rarely 3, feet in diameter. On the sandy or rocky beach, exposed to the storms of the sea, the trunk is short and crooked.

The bark is at first close, about one-eighth inch thick, and of a light

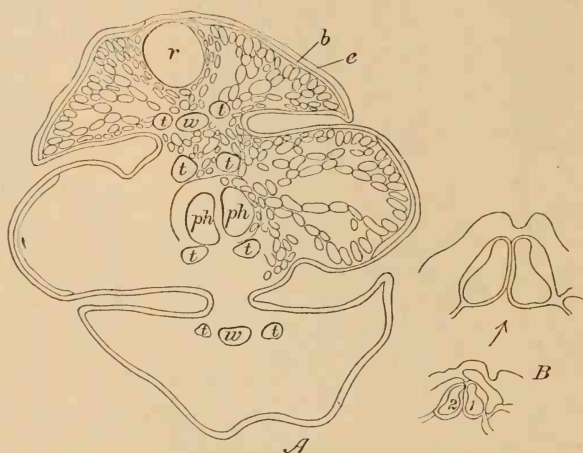


FIG. 9.—A, section through shoot passing near base of one pair of leaves and near where the other pair becomes free, same as in Fig. 8 *b*, 11, 12: *r*, resin duct; *w*, wood; *ph*, phloem or inner bast; *t*, tracheids or cells with dotted pits; *e*, epidermis; *b*, sclerenchymatous or bast layer.

B, stomata near end of leaf—greatly enlarged.

gray color on the outside; the inner bark is reddish, and soon becomes shreddy. In habit of branching, the tree presents a variety of forms. Under ordinary conditions and free exposure, the limbs are stout and more or less horizontally spreading, the crown resembling that of the Shortleaf Pine in outline. On the limestone flats, the branches soon become erect, giving rise to a pyramidal crown, and in the dense mixed forest the head assumes the spiry form characteristic of most coniferous trees. These variations can not always be ascribed to differences in soil and exposure; trees growing side by side often show great differences of form.

LEAVES.

The cotyledons are two in number, linear, obtuse (fig. 7, *q*). The primordial leaves soon cover the rapidly developing primary axis and

its ramifications in whorls of three, rarely in pairs; they are about three-eighths of an inch long and one-sixteenth wide, rigid, sharp-pointed, channeled above, with a strong midrib. The stomata (breathing pores) are somewhat irregularly placed in 4 to 5 rows in the direction of the fibro-vascular bundles. These primordial leaves

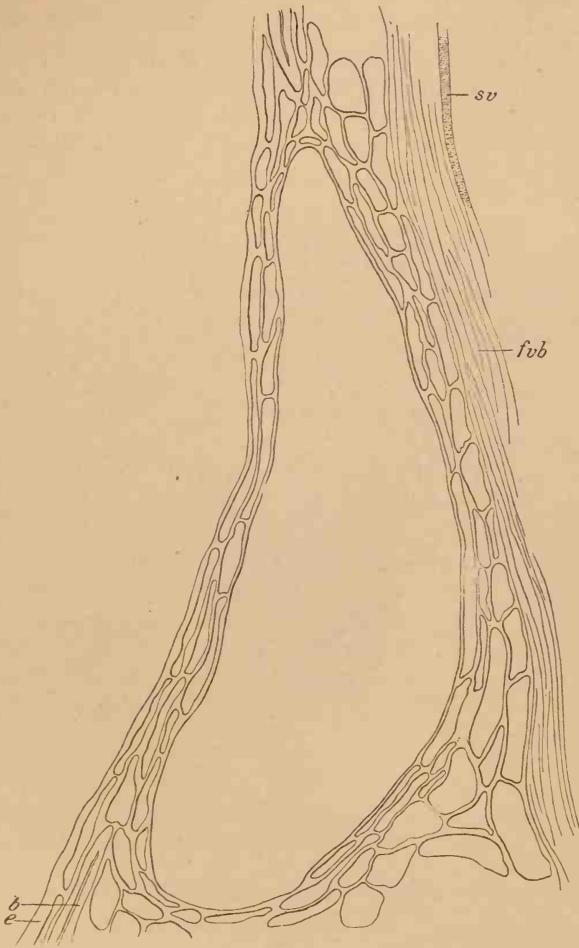


FIG 10.—Longitudinal section of resin duct: *e*, epidermis; *b*, bast or sclerenchyme fibers; *sv*, scalariform vessels; *fvb*, fibrovascular bundles—greatly enlarged.

resemble closely the leaves of the section *Oxycedrus* of the genus. They persist during several seasons, are produced in the seedlings up to the fifth and sixth year, and make their appearance on the vigorous shoots of old trees, growing from adventitious buds and from their youngest branchlets (fig. 7, *r*, *s*, *t*, *u*, *v*).

The secondary leaves (foliage leaves) constitute the mass of the foliage of the tree after it has passed the earlier stages of its growth.

In arrangement and structure they are similar to the leaves of White Cedar (fig. 7, *a*, fig. 8, *a*, *b*, and fig. 13, *a*). The leaves of Red Cedar, however, are narrower, more attenuated toward the free apical part, and with the margin entire. The dorsal and ventral rows show no difference in the form of their leaves, and the branchlets present an obscurely angled outline.

Mr. Filibert Roth says:

The epidermis consists of a layer of flattened elongated cells (fig. 10, *e*), with rather thick walls, communicating by simple pits (fig. 11, *B*), and on the inner side

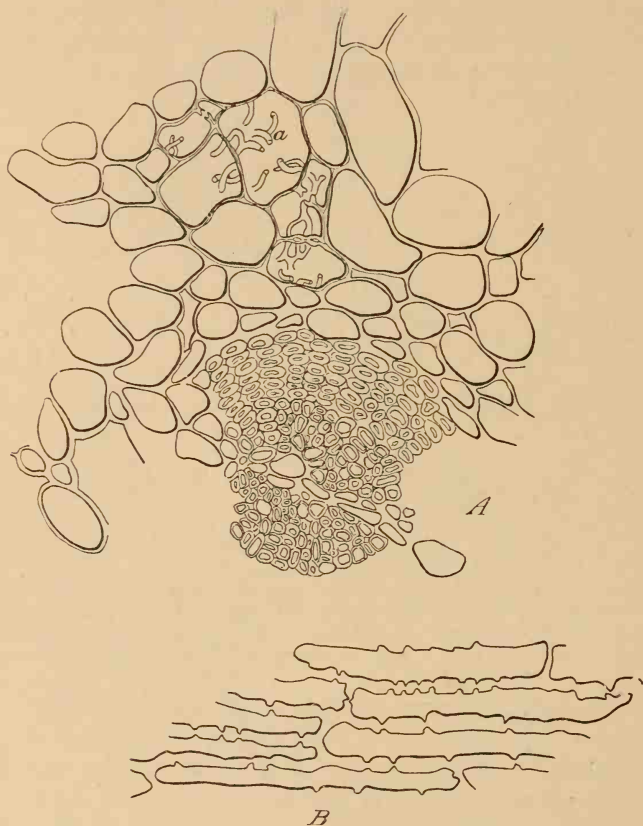


FIG. 11.—*A*, cross sections of fibrovascular bundle and its surroundings; *a*, peculiar curved projections from the walls of the tracheid cells; *B*, inner aspect of epidermis—greatly enlarged.

of the free part of the leaves the epidermis is covered by numerous stomata. On the dorsal side of the leaf the epidermis is underlaid by a simple layer of strengthening (sclerenchymatous) cells, which are doubled in the corners and also on both sides of the glands, over which the hypodermal layer does not extend. (See figs. 10, *b*, *c*, and 12, *A*, *B*.) On each side of the fibro-vascular bundle is placed a group of tracheid-like elongated cells with lignified walls and bordered pits, as is also seen on each side above and below the vascular bundle of the common leaf axis. These tracheid-like cells show the more or less peculiar curved projections from their walls, a feature characteristic of the dorso-ventral-leaved section of

Juniperus (fig. 11, *A*). The fibro-vascular bundle passes along the ventral side of the gland and contains on its border scalariform cells (fig. 10). The parenchymatous tissue is loose, composed of large cells, the palisades normal to the surface.

FLOWERS.

The flowers are generally dioecious; it is very rare that pistillate and staminate flowers are found upon the same tree. The staminate (male) flowers are sessile on the ends and sides of the ultimate branchlets, without involucre (fig. 13, *b*, *d*), the staminodial column rising from the center of the last pair of the unchanged leaves (fig. 13, *i*). They are of a yellowish buff color, scarcely one-eighth inch long, and are produced in great profusion. The floral axis produces 10 to 12

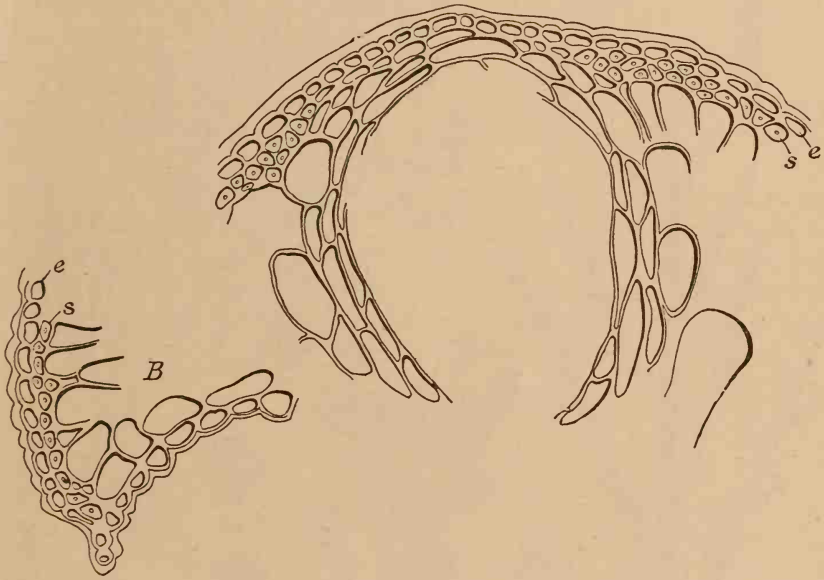


FIG. 12.—Leaf structure: *A*, section through resin duct; *B*, section through "corner," or lateral edge of leaf: *e*, epidermis; *s*, sclerenchyme or bast cells—greatly enlarged.

stamens in decussate pairs, the anthers with their convex, shield-like crest bearing from 3 to 4 pollen sacs at the base (fig. 13, *i*, *k*, *l*, *m*, *n*). The pollen is discharged by an irregular slit (fig. 13, *l*). The roundish pollen grains are somewhat irregular in shape, and roughish on the surface.

The pistillate flowers are very numerous; they are collected in a small sessile ament, destitute of involucreal bracts, and their disposition on the ultimate branchlets is similar to that of the staminate flowers (fig. 13, *a*, *c*). The inflorescence consists of two pairs of carpellary leaves placed crosswise (fig. 13, *e*, *f*, *h*). Those of the first or lower pair are broadly ovate, acuminate, and sterile; and of the upper pair, thickish with involute edges, pointed, of a pale, almost whitish color,

bearing at their base the oblong, ovate, flask-shaped ovule with the

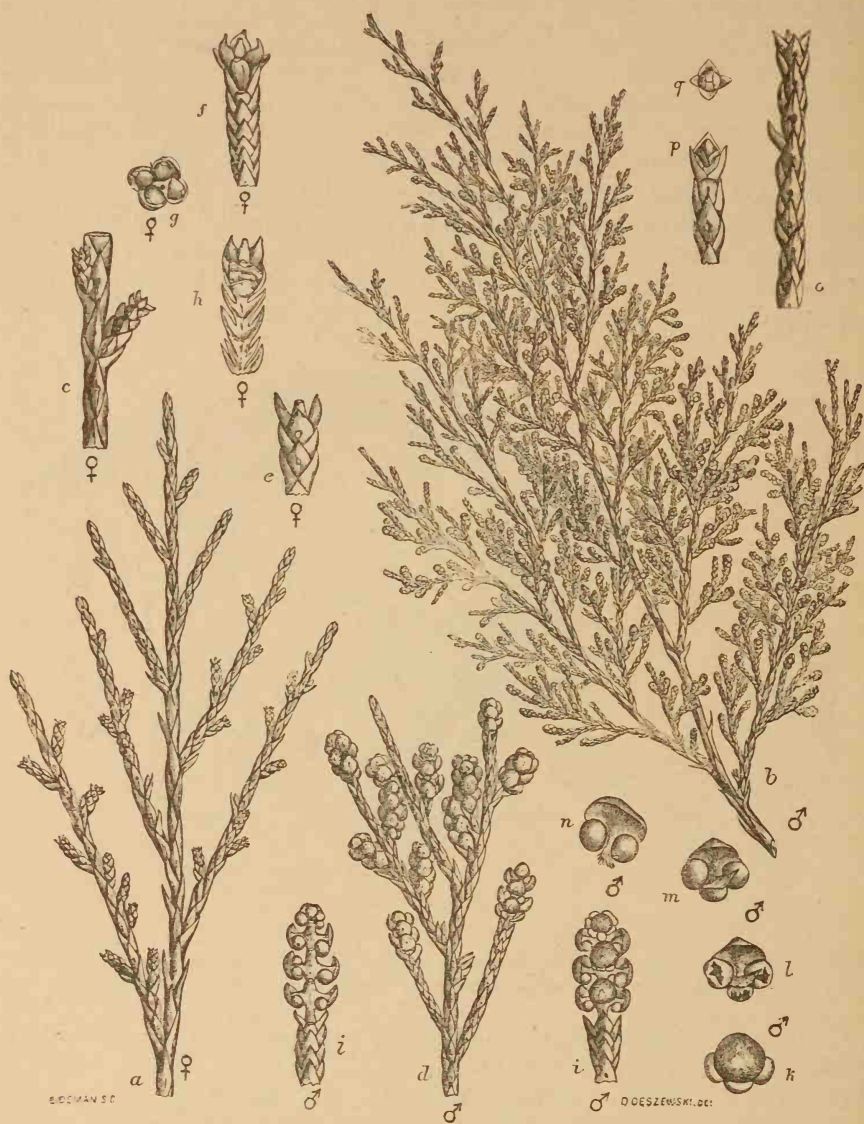


FIG. 13.—Flowers of Red Cedar; *a*, branch with female (pistillate) flowers—natural size; *b*, branch with male (staminate) flowers—natural size; *c*, pistillate branchlets—slightly magnified; *d*, staminate branchlet—slightly magnified; *e*, detached ament; *f*, ament bearing branchlet, anterior leaf of ultimate whorl bent down to show female inflorescence—enlarged; *g*, cross section of ament; *h*, longitudinal section of ament bearing branchlet, showing the pair of sterile thickened capillary leaves and one ovule—enlarged; *i*, staminate flower detached, fully open, longitudinal section of staminodial column; *k*, anther with 3 pollen sacs not yet open, seen from above; *l*, anther, ventral side, detached, pollen sacs ruptured on discharge of pollen; *m*, the pollen sacs, closed; *n*, side view of anther, with pollen sacs to the right and the left of the filament—enlarged; *o*, staminate branchlet, after pollen has been shed; *p*, ultimate male branchlet, after flower has been shed; *q*, ultimate whorl, seen from above. (Drawn from specimens collected in the District of Columbia.)

opening of the neck two-lipped. In the large number of aments

examined more than two ovules were never found, and frequently only one.

The flowers open about the beginning of March.

FRUIT.

After fecundation, the carpellary scales soon coalesce and with their increase in size soon become fleshy, the conelets assuming the form of a pulpy berry (fig. 7, *a* to *e*, *j*, *k*). This berry-like cone (galbulus) is supported by a short, erect stalk, and matures uniformly late in the fall of the first year, frequently remaining on the tree until late in the following spring. No tree has been observed to bear green and ripe fruit at the same time. The so-called berries when fully ripe are globular, about one-eighth of an inch thick, purplish black, roughish, with a whitish bloom, soft, and pulpy. The pulp incloses several vesicles filled with an oleo-resin attached to the seeds near the base, and from 1 to 2 seeds; the seeds are hard, with a thick, bony covering, ovate-oblong, and acute, with 2 or 3 prominent ridges (fig. 7, *p*) extending from near the base to the roughish apex.

The fruit of the Red Cedar is the favorite food of many birds, particularly the Carolina Waxwing, or Cedarbird (*Ampelis cedromus*), which serve as active agents in spreading the species. The tree begins to bear fruit when between 15 and 20 years old. It appears that full crops can not be depended upon every year, and that generally one or two years may elapse before another seed year occurs.

BARBADOS RED CEDAR.

(*Juniperus barbadensis* L.)

The identity of the Barbados Red Cedar as it occurs in the United States has only recently been recognized. Heretofore this cedar has been considered a southern form of the northern species. The Barbados Red Cedar occurs within a narrow subtropical coastal region extending from Georgia to Florida, and westward along the Gulf shore to eastern Texas. It occurs, also, in the mountains of Jamaica and other West Indian islands.

The specific characters of this tree differ only slightly from those of its northern ally (*Juniperus virginiana*). These distinctions consist chiefly in the minute, closely imbricated, mostly blunt, or rarely acute, leaves, which are provided with a more or less oblong, or linear, oil gland. The staminate flowers of the Barbados Red Cedar are longer than those of the northern species, and the globose, bluish-black fruit is smaller. The tree is further distinguished by its more widely spreading branches and drooping branchlets, the roundish, oval crown of the tree being rather open.

The structure and physical properties of the wood are practically alike in both species.

